Reducing earthquake and tsunami hazards in Pacific Northwest ports and harbors—Protecting our Ports and Harbors Project

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Abstract. While ports and harbors represent significant elements of a coastal community, very little harbor-specific planning has been done to examine their risk and vulnerability, or to identify ways to minimize loss of life and damage to vessels, waterfront businesses, and other waterfront operations. At the same time, ports and harbors are likely to be of paramount importance in disaster response and recovery operations, serving as principal links to the outside world. The Protecting our Ports and Harbors Project primary objectives include the identification of earthquake-tsunami issues relevant to ports and harbors along the Oregon and Washington coast, and the development of a community-based co-seismic hazards mitigation planning process. The projects emphasis on hazards assessment and analysis, combined with partnership building and public education, employs a methodology that should help increase the resilience of ports, harbors, and their surrounding communities to earthquake and tsunami hazards.

1. Introduction

Location and geologic conditions contribute significantly to the earthquake and tsunami vulnerability of ports and harbors along the U.S. Pacific Northwest coast. Even though the U.S. Pacific Northwest has had a minimal incidence of major earthquake or devastating seismic-related events in recent years, scientific studies indicate that there is about a 10 to 20 percent chance for such an event before the year 2050. When the next major earthquake occurs, transportation lifelines could suffer severe impacts and take many months or even years to reestablish. Therefore, sound hazard mitigation practices must focus on understanding the vulnerability of ports and harbors to earthquake-tsunami hazards and develop ways to increase their

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resiliency. In this project, researchers at Oregon State University, Oregon Sea Grant, Washington Sea Grant, and staff with the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey formed a partnership to address seismic hazards, with an emphasis on tsunamis. The project's ultimate goal is to increase the resilience of ports, harbors, and their surrounding communities to earthquakes and local and distant tsunami hazards.

Principal objectives of the Protecting our Ports and Harbors Project include the identification of earthquake-tsunami issues relevant to ports and harbors in the U.S. Pacific Northwest region. The project team will then study the information and data needed to assess the region's risk and vulnerability. Project work will culminate in the development of an educationally focused Internet site (http://www.csc.noaa.gov/products/tsunamis/) and a geographic information system (GIS)-based hazard mitigation model. Those who access the project's Internet site can refer to an interactive tsunami-focused glossary, an annotated bibliography of earthquake-tsunami research conducted in the Cascadia region, and a comprehensive index of hypertext links about tsunamis. In addition, a key component of the Internet site will consist of an on-line mapping application that will allow users to interactively view and download spatial data.

This project will also undertake demonstration projects, one each in Oregon and Washington, to develop, test, and evaluate various mitigation strategies and tradeoffs to help increase the resiliency of lifelines, infrastructure, and facilities in and around ports and harbors. Another important goal of the project is to transfer the lessons learned to other port and harbor communities. When a great earthquake does strike the region, ancillary benefits will include the reduction in loss of life and a stable transportation link for disaster response and recovery. Other potential benefits of the project include the reduced potential for business interruption, social disruption, and environmental damage. The Protecting our Ports and Harbors Project emphasis on hazards assessment and analysis, combined with partnership building and public education, employs a methodology that should help increase the resilience of ports, harbors, and their surrounding communities to earthquake and local and distant tsunami hazards.

2. Location

Along the Pacific Northwest coast, earthquake and tsunami hazards are extremely prevalent. The convergence of the Juan de Fuca tectonic plate and the North American tectonic plate is the most immediate cause for seismic hazards in the Pacific Northwest, also known as Cascadia. The place at which these two plates meet is generally known as the Cascadia Subduction Zone (CSZ). It is in this zone, where the Juan de Fuca plate is subducting below the North American plate, that the most intense earthquakes have occurred in the geologic past for the Pacific Northwest region. Evidence suggests that a large earthquake event, magnitude 9.0, occurred along the CSZ in the year 1700 A.D. (Satake *et al.*, 1996). The recurrence interval for

Figure 1: A view of the project web site.

earthquakes of this magnitude has been estimated to be 300 to 500 years, which would mean the region is now in the recurrence interval window (Atwater and Hemphill-Haley, 1997).

Coastal communities of the Pacific Northwest are potentially vulnerable to several hazards produced by seismic events. Some of these hazards include severe ground shaking, liquefaction of unconsolidated soils, landslides, land subsidence, flooding, and tsunamis. All of these hazards have the potential to cause loss of life and extreme damage to residential, commercial, and industrial facilities. In addition, transportation and utility systems could be particularly vulnerable to damage. Ports and harbors in the Pacific Northwest are especially susceptible to damages caused by seismic events. Ports and harbors not only provide the economic base for several communities on the Pacific Northwest coast but also are important areas from which to launch rescue or relief efforts after a tsunami occurs. Therefore, it is imperative to develop strategies for reducing the impacts of seismic events in this region.

3. Education and Outreach

The NOAA Coastal Services Center is developing a Web-based tool to support the Protecting our Ports and Harbors Project (Fig. 1). The Web site consists of two major components: a Cascadia regional risk atlas that addresses the seismic hazards that are most prevalent across the Pacific Northwest; and the ports and harbors planning process being developed by Oregon and Washington Sea Grant, for reducing the impact of seismic hazards. The purpose of the web site is twofold: to provide educational information about coseismic hazards in the Cascadia region of the Pacific Northwest; and to highlight and illustrate a regional planning tool being developed by Oregon and Washington Sea Grant to help reduce the impact of seismic hazards.

The project Web site addresses the general seismic hazards that threaten the Pacific Northwest: earthquakes, liquefaction, landslides, subsidence, and tsunamis. This first section is divided into three major components: regional vulnerability, resources, and mitigation. The regional vulnerability section addresses the vulnerability of ports and harbors to seismic hazards in the Cascadia region. This section also contains a map gallery that allows individuals to gain an understanding of the important ports and harbors in this region and their associated seismic risks. The resources section contains a glossary of seismic hazard terms, a bibliography of related information, preparedness tips for seismic hazards, a list of Internet links to related seismic hazard Web sites, and a list of data resources. The mitigation section addresses the various forms of mitigation being conducted for seismic hazards in the region.

4. Regional Planning Tool

It is envisioned that a broad-based planning and mitigation process could be used by local communities to assess the vulnerability of their ports and harbors to seismic hazards. There generally is local concern for the natural hazards in the area, and the hazards pose a significant threat to essential local resources. In addition to outreach, a planning tool designed to help communities mitigate the impacts of earthquake and tsunami hazards is being developed by Oregon and Washington SeaGrant, the NOAA Coastal Services Center, and the USGS. The first step involved in developing this process is to organize a core team of individuals that will coordinate the planning process, conduct public meetings, obtain financial assistance, and develop the local hazards geographic information system (GIS). Organizing advisory groups is also a component of this first step. A final component of this first step is adapting the process to local hazards and coastal resources. This is achieved through community group meetings, focus groups, and personal interviews.

Step two involves holding at least three technical assessment workshops. The purpose of the first workshop is to assess the hazards and risks of the area and develop hazard scenarios. Determining the vulnerability of the natural and developed environments and the social, economic, and political implica-

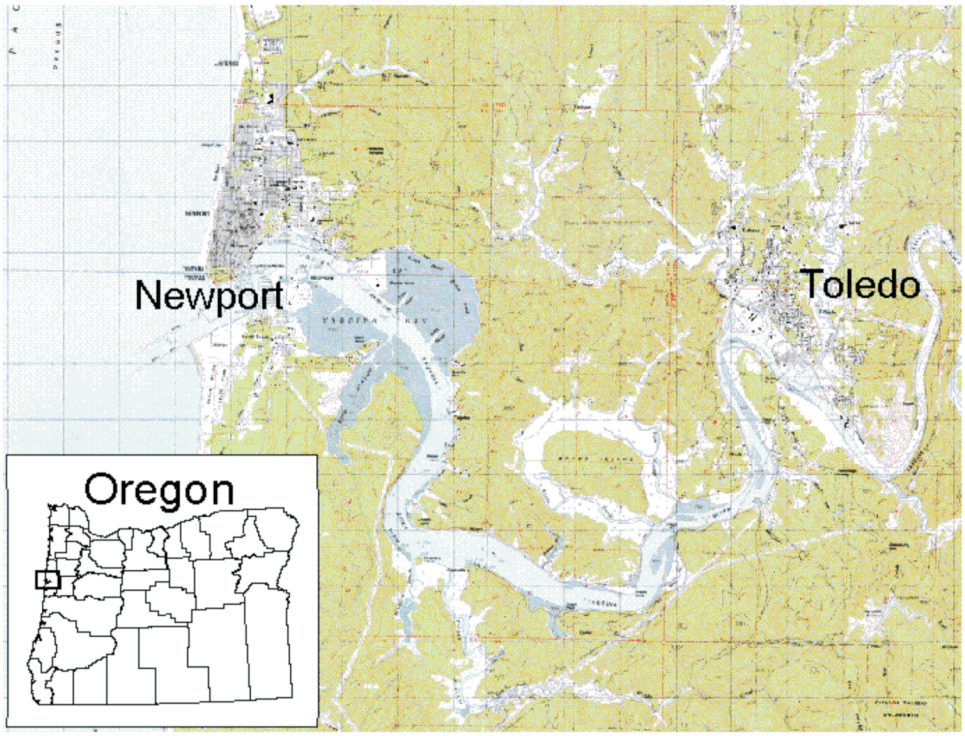

Figure 2: Yaquina Bay, Oregon

tions is a goal of the second technical workshop. During the final workshop, response strategies and structural and nonstructural mitigation options are explored. Again, before moving on to step three, a public meeting is held to explain the results of the workshops and present the mitigation options. The final step involves developing and implementing mitigation strategies. Components of this step include designing complementary mitigation strategies, planning implementation actions, and establishing a monitoring process. Below is a description of a case study in which the above-mentioned process is being used to assess the seismic risk and vulnerability of the ports of Yaquina Bay, Oregon.

5. Case Study: Yaquina Bay, Oregon

The planning process described above is being used for a demonstration project at Yaquina Bay, Oregon, which contains the ports of Newport and Toledo (Fig. 2). The port city of Newport, located at the mouth of Yaquina Bay, is home to approximately 9,000 people and contains the largest fishing and fish processing industries on the West Coast. Along with the port facility, the historic waterfront district is located along the bay and is a host to a variety of residential and commercial uses. The port city of Toledo is located 7 miles inland on the Yaquina River. Toledo is a town of approximately 3,400 residents, and the port here supports small commercial and

recreational vessels. The goal of this local assessment is not only to explore the risk reduction and mitigation strategies for seismic hazards of the ports of Yaquina Bay, but also to develop a methodology that local organizations, governments, and interested citizens can use to assess the risk and vulnerability of their ports and harbors.

6. Future Work

The Yaquina Bay project will be monitored and evaluated, and a comprehensive Yaquina Bay case study will be developed. The Yaquina Bay project is the first of two scheduled projects; the second will occur in the State of Washington. After both of these projects have been completed, the results of the projects will be evaluated, training materials will be developed, and a dissemination strategy will be implemented. A regional training program through port organizations and other venues will then be implemented for the Pacific Northwest.

7. References

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